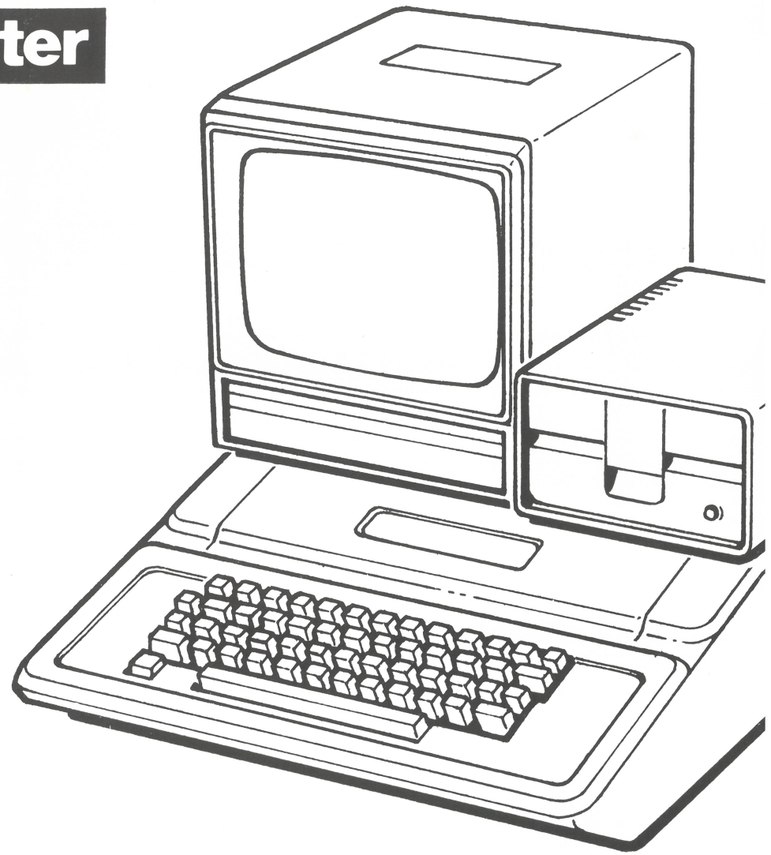
E.M.E

microcomputer program



WATER IN THE AIR

STUDY GUIDE

by

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This program uses a high-speed operating system called Diversi - DOS (tm) under license. For information contact DSR, Inc., 34880 Bunker Hill, Farmington MI 48018.

OVERVIEW

The E.M.E WATER IN THE AIR program will help upper-elementary and middle school students solve problems dealing with water in the atmosphere. The program consists of two parts:

1. Explanations -- (a) evaporation, condensation and sublimation
   (b) light and heavy molecules
   (c) sources of water vapor

   A convenient forward/backward feature allows review at any point.

2. Quiz -- consists of 25 randomly-selected questions where the student solves problems dealing with evaporation, condensation, sublimation and transpiration. A short explanation is provided if a question is incorrectly answered. The student's score is given at the end.

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OBJECTIVES

The following concepts are developed in the program:

1. Matter exists as solids, liquids and gases.
2. Normally as energy is added, a solid changes to a liquid then to a gas. As energy is removed the normal sequence is gas to liquid to solid. However, some solids can change directly to a gas and some gases can change directly to solids without becoming liquids.
3. Energy is required to evaporate a liquid. The rate of evaporation increases as the level of heat energy is increased.
4. The energy for evaporation comes from outside the evaporating matter.
5. An increase in surface area results in an increase in the rate of evaporation.
6. When loss of energy in water vapor reaches a certain point condensation occurs.
7. Water vapor does not carry any dissolved substances in it.
8. Gases in containers of equal size, at the same temperature and pressure hold the same number of molecules.
9. Seventy percent (70%) of the earth's surface is covered by oceans; most of the water vapor in the air comes from the oceans.
10. Leaves of green plants, the breathing of humans and animals, and the burning of fuels are other sources of water vapor.
11. A specific volume of dry air is heavier than the same volume of moist air.

12. The principal processes involved in the water cycle are evaporation and condensation.

After using this program the student will be able to:

1. define evaporation, condensation, transpiration, water vapor and sublimation.
2. explain the water cycle and identify sources of water vapor.
3. design an experiment showing that evaporation leaves dissolved substances behind.
4. understand why things cool when water evaporates from them.
5. state whether energy is lost or gained by evaporation and condensation.
6. determine which is heavier, a certain volume of dry air or the same volume of moist air.
7. design an experiment which shows that a larger surface area results in a faster rate of evaporation.
8. explain the process of condensation and design an experiment which shows condensation.

USING THE PROGRAM

The E.M.E WATER IN THE AIR program is easy to use and is under your control at all times. The program loads automatically and is ready to use immediately. We suggest that you start with the Explanation section. This provides the student with background needed to understand water in the atmosphere and to answer the questions in the Quiz. This program is designed for grades 5 and up.

You may wish to assign one student who has taken the quiz as your representative at the computer to record the scores of other students who take the quiz. WATER IN THE AIR may also be used as an evaluation instrument by teachers who have completed a unit on the topic of weather.

BACKGROUND

Much of our weather is caused by water in the air. To understand what causes rain, snow, humidity and cloudiness, it is essential to understand evaporation, the principal process by which water enters the air. Evaporation requires energy. The more energy absorbed by a liquid the faster the rate of evaporation.

To show the effect of temperature on evaporation, have students put equal amounts of water into two identical containers. Heat one container over a hot plate or other heat source. Leave the other container at room temperature. Ask the students to predict the outcome of this experiment. The heated container will have a faster rate of evaporation than the one left at room temperature.

Another way of showing the effect of heat on evaporation is to put equal amounts of water in similar containers (TV dinner trays work well). Place one tray in a sunny place and the other in shade. After 24 hours have students measure the remaining water and compare results. The tray in the sun should have less water left.

When energy is absorbed by water, some of the water molecules leave the liquid and mix with air. This invisible form of water is known as water vapor. Wind speeds the evaporation process, as anyone knows who has hung clothes on a line to dry. Wet clothes dry faster on sunny and windy days rather than sunny calm days.

An experiment in class will verify this. Wet two pieces of cloth, same size and material; two handkerchiefs work well. Place both on a line in a sunny place some distance apart. Direct the air flow from a room fan onto one of the handkerchiefs. You will find that the one in the path of the airflow dries much faster.

To demonstrate the effect of wind on a wet surface, wet two spots on the class chalkboard. Fan one wet spot with a piece of cardboard or book. Do not fan the other spot. Students will observe that the spot which was fanned disappears (evaporates) more quickly than the unfanned spot.

Water Cycle

The sun is the energy source behind the movement of water, from sea to sky to land and to sea again. This pathway is called the water or hydrologic cycle.

The water cycle begins at sea. Here water molecules at the surface, heated by the sun, change from a liquid to a gas and escape into the atmosphere. Millions of

metric tons of water are evaporated from the world's oceans every second. Although water evaporation occurs anywhere on the earth's surface, the oceans account for 80% of the total. As evaporation takes place, tremendous amounts of heat are absorbed by the oceans from the atmosphere. Thus, the water cycle has a powerful influence on climate.

Because water vapor is colorless, it flows invisibly through the atmosphere. Carried by the winds, it sweeps over the continents. Wherever the flow encounters cooler air, tiny water droplets form and become visible as clouds. The appearance of clouds marks the next step in the cycle -- the change of water from vapor to liquid again -- called condensation. Not all clouds are liquid, for in extremely cold air the droplets freeze to become tiny ice crystals. Cirrus clouds are an example of "ice clouds".

In a dense cloud the water droplets are constantly colliding and joining to form larger and larger drops. Soon even the strongest winds cannot keep them aloft. They fall as precipitation, bringing the ocean's water, now fresh, to even the highest mountains. The precipitation may be in the form of rain, sleet, hail or snow depending on the temperature.

On the surface, heavy rains fill the soil and tiny rivulets appear. These trickle across the land finding their way to streams and rivers on their journey back to the ocean. If you were to follow a water molecule in its many trips through the water cycle you would find on average it spends about 98% of its time in the ocean. About 1½% of the time it would be locked in glacial ice, and the remaining ½% in lakes, rivers and the atmosphere.

Plants and trees are another significant source of atmospheric water vapor. They draw large amounts of water through their roots to their leaves. After useful minerals are withdrawn most of the water escapes from the leaves as water vapor. This process is called transpiration.

The burning of fuels also contributes water vapor to the atmosphere. Often you can see the white trail of a jet as it flies overhead. Part of this trail is water vapor, as is the exhaust from an automobile on a cold day. Breath and perspiration from people and animals are also sources of water vapor.

To illustrate condensation, use an aluminum pan or metal measuring cup and some ice cubes. Mix the water and ice cubes in the container. After a few minutes, droplets of water will form on the outside of the container. Allow students to speculate about the source of these droplets. If some think the container leaked, suggest they add food coloring to the water in the container to see if the droplets on the outside become colored.

To confirm this, fill a similar pan or cup with hot water. Do droplets form on the outside of this container? No, droplets do not form on the pan with hot water. Therefore, it is reasonable to conclude that the water droplets come from water vapor in the air. Another example of condensation is when we exhale and "see" our breath on a cold day.

Sublimation is change directly from a solid to a gas without going through the liquid state. An example of this process is the dry ice (solid carbon dioxide) used as a coolant. During hot weather dry ice does not melt, it just seems to disappear. The solid carbon dioxide changes directly to a gas as heat is absorbed. Solid forms of water such as ice and snow also will sublimate. In areas that have cold and clear winter days, snow banks slowly contract without melting. The missing snow has changed directly to water vapor.

The term sublimation is sometimes applied to the reverse process -- that of changing from a gas directly to a solid. However, the term condensation is used more frequently to describe water vapor changing directly from gas to solid without passing through a liquid state.

Light and Heavy Molecules

Water molecules have less mass than most molecules found in air. When water molecules enter the air they usually displace molecules of greater mass. The mass of atoms and molecules is measured in atomic mass units (amu). Water has 18 atomic mass units. Of the other contents of air, nitrogen (the most common) has 28 atomic mass units, oxygen has 32 and carbon dioxide has 44.

Nearly 175 years ago an Italian scientist named Avogadro discovered that identical containers at the same pressure and temperature have the same number of molecules of gas in them. It does not matter what kind of gas or what mixture of gases is chosen, the number of molecules in each container is the same. A container of moist air has the same number of molecules as an identical container of dry air at the same temperature and pressure, but the mass of the moist-air molecules is less than that of the dry-air molecules. This can be seen by looking at the atomic mass units of the molecules that make up air. Water at 18 amu is the lightest gas in air. Nitrogen (28), oxygen (32) and carbon dioxide (44) are all much heavier. Therefore, air with water in it has a lower mass than dry air.

It is useful to consider the evaporation of water vapor with Avogadro's principle in mind. As water molecules (of less mass) enter the air (consisting of molecules with greater mass), light molecules displace heavier molecules, molecule for molecule. The heavier air molecules tend to settle; the lighter water molecules tend to rise. The resulting air circulation leads to weather changes.

STUDENT WORKSHEET ANSWERS

I.
1 - False
2 - True
3 - False
4 - False
5 - True
6 - True
7 - True
8 - True
9 - True
10 - True

II.
1 - energy or heat
2 - oceans
3 - sublimation
4 - dissolved
5 - fuels
6 - energy,energy
7 - greater
8 - condenses
9 - molecules
10 - rain,snow
11 - seventy
12 - cold,warm
13 - transpiration

GLOSSARY

atomic mass unit (amu): A unit used to measure the mass of atoms and molecules.

condensation: The process of changing from a gas to a liquid or a gas to a solid.

evaporation: The process of changing from a liquid to a gas.

sublimation: The process of changing from a solid to a gas without going through the liquid state.

transpiration: The passage of water vapor from plants to the air.

water vapor: A gas that results from the evaporation of water.

RESOURCES

Books

Alth, Charlotte and Max: DISASTROUS HURRICANES AND TORNADOES, Franklin Watts, New York, 1981

Ardley, Neil: WORKING WITH WATER, Franklin Watts, New York, 1983

Arnov, Boris: WATER: EXPERIMENTS TO UNDERSTAND IT, Lothrop, New York, 1980

Aylesworth, Thomas G. STORM ALERT: UNDERSTANDING WEATHER DISASTERS, Messenger, New York, 1980

Davis, Hubert: A JANUARY FOG WILL FREEZE A HOG, AND OTHER WEATHER FOLKLORE, Crown, New York, 1977

Kwitz, Mary DeBall: WHEN IT RAINS, Follett, Chicago, 1974

Films

CONVECTIVE CLOUDS, Meteorological Society Film Series, Ward's Natural Science, Rochester, N.Y. (27 minutes)

A STORY OF A STORM, Coronet Films, Chicago, IL (11 minutes)

THE WATER CYCLE, Encyclopedia Britannica Films, Chicago, IL (14 minutes)

WEATHER - UNDERSTANDING PRECIPITATION, Coronet Films, Chicago, IL (11 minutes)

WHAT MAKES CLOUDS, Encyclopedia Britannica Films, Chicago, IL (19 minutes)

Software

WATER POLLUTION, E.M.E, Post Office Box 17, Pelham, N.Y., 1985

Name_____ Student Worksheet I

WATER IN THE AIR

True or false. Circle the T if you think the answer is true. Circle the F if you think the answer is false.

T F 1. The water cycle involves evaporation only.

T F 2. Energy is required for something to evaporate.

T F 3. Water vapor carries dissolved substances in it.

T F 4. A certain volume of moist air is heavier than an equal volume of dry air.

T F 5. As water evaporates, the body of water from which it evaporates is cooled.

T F 6. The largest source of water vapor in the air is evaporation from the oceans.

T F 7. If you pour equal amounts of water into two containers, the water in the container with the larger surface area should evaporate quicker.

T F 8. Energy must be removed from water vapor for it to condense.

T F 9. Avagadro discovered that identical containers of any gases at the same temperature and pressure have the same number of molecules of any gas in them.

T F 10. Water vapor is released by the green leaves of trees.

Name_____ Student Worksheet II

WATER IN THE AIR

Fill in the blanks using the following words:

cold	fuels	oceans	sublimation
condenses	greater	rain	transpiration
dissolved	heat	seventy	warm
energy	molecules	snow	

1. Water needs_____to evaporate and become water vapor.

2. Water vapor is always entering the air from the_____.

3. The process of_____involves a solid becoming a gas without becoming a liquid.

4. Water vapor does not carry any_____substances in it.

5. The burning of_____is a source of water vapor.

6. Evaporation is a process that absorbs_____and condensation is a process that releases_____.

7. Most of the molecules in air have_____mass than water molecules.

8. As water vapor loses energy it_____to liquid water.

9. Identical containers at the same temperature and pressure have the same number of_____of a gas in them.

10. Water vapor in the air may return to the earth in the form of_____ and_____.

11. _____percent of the earth's surface is covered by oceans.

12. _____air cannot hold as much water vapor as_____air.

13. Leaves of plants release water vapor in a process called_____.

TEXTBOOK CORRELATION GUIDE

Addison Wesley	
Science	Book 6, Chapter 2
Coronado	
Science & Technology	Book 4, Unit 1, Chapter 2
	Book 5, Unit 2, Chapter 7
Harcourt Brace	
Science	Book 4, Unit 5, Chapters 1-6
Heath	
Science	Book 3, Unit 2, Chapter 4
	Book 4, Unit 2, Chapter 5
	Book 5, Unit 2, Chapter 3
Holt	
Elementary Science	Book 4, Unit 3, Chapter 10
Laidlaw	
Exploring Science	Book 4, Unit 5, Chapters 1,2
Merrill	
Accent on Science	Book 1, Chapter 5
	Book 3, Unit 4, Chapters, 1,3
	Book 5, Unit 3, Chapter 1
Scott Foresman	
Science	Book 4, Unit 2, Chapters 3,4
Silver Burdett	
Science	Book 1, Unit 9
	Book 2, Unit 7
	Book 3, Unit 3, Chapter 11
	Book 4, Unit 3, Chapter 11
	Book 5, Unit 3, Chapter 11